CHAPTER 5
CONCLUSION AND FUTURE WORK

5.1 Conclusion

In this work, a numerical study was conducted to investigate the scale effect in free-surface flow modeling with turbulent regime. As a case study, the turbulence wakes behind conical island was selected. The numerical simulations were conducted in two stages. The first phase was to verify whether the numerical model was in agreement with the experimental data performed by Llyod and Stansby (1997). The second one was the simulations using an upscaling factor to investigate the scale effect, especially in the recirculating flow area. To accomplish these two stages, three numerical cases were considered (with the scale factors of 1, 3, and 10), which were conducted using the Large Eddy Simulation (LES) model within the framework of an open-source code (OpenFOAM v2012).

For all cases, the Froude similarity was used, thus regardless of the scale factor, the Froude number for each numerical simulation was same with the experimental data, namely Fr = 0.158. For the first case (scale factor of 1), it was shown that OpenFOAM could properly predict the experimental data, where the velocity magnitude and vortices period were identical with the observed data. It can therefore be concluded that OpenFOAM was able to replicate the experimental data with a relatively low margin of error.

After the verification against experimental data, we proceeded to the investigation of scale effect using upscaled models. The result showed that the scale effect appeared in the recirculating turbulent flow zone for both velocity magnitude and vortices period. We found that the scale effect was quite significant. However, for the non-recirculating flow, the scale effect was not significant. This evidence proves our hypothesis that the scale effects due to the Froude similarity is quite significant when the recirculating turbulent flow occurs.

5.2 Future Work

Future research may be conducted to investigate the scale effects due to the Reynolds similarity. Additionally, mesh size effect is worth to be pointing out for the investigation of scale effects.

Furthermore, future research may also include different approaches, such as using the other types of Large Eddy Simulation model, which employs the other sub grid scale model, such as Wall Adapting Local Eddy-viscosity (WALE) model or SGS-free models. Also, it may be interesting in the future to utilize Direct Numerical Simulation (DNS) model, which is considered as the most 'physically realistic' model that purely relies on the numerical method to solve Navier-Stokes equation, thus involving no turbulent model.

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